STEARNS & WHELER PLLC
Environmental Engineers & Scientists

TECHNICAL MEMORANDUM
DRAFT

To: Little River Reservoir Project Review Team

From: Stearns & Wheler GHD

Date: July 8, 2009

Re: Proposed Little River Water Treatment Plant
Site Evaluation and Selection

INTRODUCTION

Background

The City of Raleigh operates and maintains the E.M. Johnson Water Treatment Plant (WTP), which is rated for 86 million gallons per day (mgd), and which withdraws raw water from Falls Lake. The City plans to expand the plant to 100 mgd. The City's D.E. Benton WTP, which is currently under construction, will provide an additional 20 mgd of potable water from Lakes Benson and Wheeler, and will commence operations in 2010.

As part of the City's long-term water supply planning, Raleigh is pursuing a new reservoir in eastern Wake County. The new reservoir will impound approximately 3.7 billion gallons, providing a 50-year safe yield of approximately 13.7 mgd. A new water treatment plant in relative close proximity to this water supply will deliver finished water to the City's distribution system. Stearns & Wheler is assisting the reservoir team by facilitating a site evaluation and selection process for this new water treatment plant.

The new water supply intake, pumping station, and treatment plant will have a maximum day capacity of 20 mgd. Distribution piping will connect to Raleigh's existing system at two points, each in a different pressure zone. The connection points were established as part of the City's Water Quality Study and Master Plan Update, completed in February 2008. One connection point is to an existing water main near the intersection of NC 97 and Wendell Boulevard (462 pressure zone). The other connection point is to an existing main near the intersection of NC 97 and Green Pace Road (497 pressure zone).

Purpose

The purpose of the Little River WTP Site Evaluation and Selection project is to provide the City of Raleigh with a technical basis for evaluating and selecting an appropriate site. Objectives of the evaluation include:

- Review parcel maps and GIS data to determine the most appropriate sites.
- Determine a reasonable footprint for the proposed treatment plant.
- Verify screening criteria and source data.
- Develop a scoring methodology for weighting each of the selection criteria, and apply this methodology to the identified sites.
- Conduct field investigations of short-listed sites.
- Develop a technical memorandum summarizing the site evaluation and selection process, and making site selection recommendations.

This site evaluation and selection process is part of the larger Environmental Impact Statement (EIS) currently being prepared for the reservoir project. The EIS requires the City to address impacts resulting from the water treatment plant and its associated raw and finished water and wastewater discharge piping.

Methodology

The site evaluation and selection process is a multi-step procedure. The first step involves estimating the quantity of land necessary for the treatment plant based on impervious surface requirements and process footprints. The second step involves identification of a superset of possible sites, based solely on parcel(s) size. The next step defines the criteria that will be used to evaluate sites and assign a relative score for each. The final step involves application of the scoring system to each identified site to develop a short-list of three possible candidate sites.

Location

Possible Little River WTP sites have been established based on a review of aerial photography and mapping data (using Wake County's GIS data), using the following general guiding principles:

1. Site located on large tract(s) of undeveloped land. Selecting areas with large tracts of undeveloped land in the hopes of minimizing the number of property owners directly impacted.

2. Relatively close proximity to the proposed Little River Reservoir intake.

3. Relatively close proximity to the service line connections.

Selecting sites close to the intake and service line connections reduces the length of raw and finished water pipelines, minimizing direct environmental and property owner impacts, and capital expenditures for construction.

Footprint Determination

During the early stages of site selection, it is critical to estimate the amount of land necessary for the new water treatment plant. To determine the appropriate amount of built upon area, or the amount of impervious surface required for the new treatment plant, a survey of water treatment plants of similar size was conducted. Three similar sites, the City of Raleigh's D.E. Benton WTP; the Binghamton WTP, in Binghamton, New York; and the Onondaga County WTP in Marcellus, New York were used to determine an average treatment capacity per acre. Table 1 summarizes the estimation of impervious surface requirements.

Table 1 – WTP Average Impervious Surface Requirement

Facility	Treatment Capacity (mgd)	Lot Size (Acres)	Impervious Surface (Acres)	mgd/Acre
D.E. Benton	20	54	8.5	2.35
Binghamton, NY	20	14.4	14.3	1.40
Onondaga County, NY	20	60	6.7	2.99
			Average	2.3

Using an average of 2.3 mgd per acre to calculate the required built-upon area for a 20-mgd plant, approximately 8.7 acres will be required for the Little River WTP. Applying a safety factor of 1.5 to the estimated impervious surface requirement allows for site and process uncertainty at this stage of planning. The estimated impervious surface requirement for the new 20-mgd facility is thus 13 acres.

With an estimate of treatment facility impervious surface, an estimate of the required parcel size can be developed using limits in Wake County's zoning ordinances. Wake County has the following impervious surface limits:

Table 2 – Wake County Impervious Surface Limits

Zoning	Impervious Surface Limit
R-80W	6% for non-residential within watershed
R-40W	12% for non-residential within watershed

In addition, the County specifies that developments with an impervious surface greater than 15% are required to install stormwater control devices.

For sites within the Little River Reservoir watershed, the more stringent R-80W and R-40W impervious surface requirements apply. Where parcels inside the watershed are comprised of land in both R-80W and R-40W, a mix of impervious surface limits will apply. Table 3 summarizes the necessary acreage for a variety of R-80W and R-40W splits.

Table 3 – Required Parcel Size Inside Watershed (based on 13 impervious acres)

Percentage R-80W vs. R-40W	Land Requirement (acres)
0/100	108
10/90	119
20/80	130
30/70	141
40/60	152
50/50	163
60/40	173
70/30	184
80/20	195
90/10	206
100/0	217

Sites outside the proposed Little River Reservoir watershed have been limited to no more than 15% impervious surface to eliminate the need for stormwater control devices. Limiting impervious surface to 15% of the total parcel stipulates a site size of approximately 87 acres.

Multi-Criteria Analysis

To determine the suitability of sites for a new water treatment facility, multiple criteria must be considered. Generally accepted site selection criteria for water treatment facilities include:

- Proximity of site to source water and customers
- Proximity of site to interconnects and distribution system
- Environmental and land use concerns
- Subsurface and geotechnical considerations
- Land availability, cost, and zoning
- Storage requirements at the plant site
- Compatibility with existing and planned surrounding development
- Availability of utilities
- Site topography and accessibility

Each criterion has been assigned a weight so that individual sites can be scored in an unbiased fashion. Sites with the highest scores are candidates for the final evaluation and selection process. This approach is also known as the Multi-Criteria Analysis (MCA) approach.

MCA is ideally suited to complex decision-making and provides a structured framework for managing and evaluating large amounts of information. One feature of MCA that is different from other methodologies used in the site selection process is weighting. Weighting each criterion allows the team to make value-based decisions on how important each criterion is in relation to the other criteria. The basic elements of any MCA process are:

1. Planning the MCA, including deciding which of a number of available analytical methods should be used and who should be involved.

2. Identifying criteria against which each site is to be assessed.

3. Scoring each site according to each criterion, i.e., undertaking impact assessments to determine how well each site performs for each criterion.

4. Weighting each criterion, i.e., making a value-based decision on how important a particular criterion is in relation to the other criteria

Analyzing the results by combining the scores and weights for each criterion generates a picture of the performance of each site in relation to the other sites. The MCA is a decision-*aiding*, not a decision-*making* tool. MCA can provide detailed information; responsibility for the final selection of a short-listed site rests with the City of Raleigh. Furthermore, while the MCA process provides a detailed picture of the respective criterion implications of the different site options, it does not indicate whether the residual impacts are acceptable to the City of Raleigh.

The criteria considered during the site evaluation and selection process are described in detail below.

Biodiversity

This criterion relates to the biodiversity values of the site, including the clearing of land necessary to accommodate the facility. Biodiversity is the variety of all life forms, the different plants, animals and microorganisms; the genes they contain; and the ecosystems of which they play an important role. In the case of the proposed WTP, the issues to be considered under the criterion of impact on biodiversity are:

- The overall ecological value of the sites;
- The conservation significance of the sites;
- The clearing required at the sites (the amount of native vegetation that will be cleared);
- The value of the site for native flora, specifically, the diversity of native flora at the site, any significant flora species or vegetation types at the site and the health of the vegetation at the site;

To evaluate this criterion, maps with endangered and imperiled species of flora and fauna will be used to determine their location and proximity to preliminary WTP sites. Sites closer to habitats for endangered or imperiled species are given less preference.

Proximity of site to raw water pumping and finished water interconnects

The proximity of the proposed treatment facility to the raw water pumping station and the finished water connection points relates to the quantity and types of materials used in the construction, and will be related to the lengths of pipe required for each site.

Waterways

This criterion relates to the potential impacts of the WTP on waterways, which for this purpose includes river and stream systems and wetlands. The desired environmental goal for this criterion is that waterways (including minor drainages) and associated riparian vegetation be protected, and that development should be excluded from the buffer area of a waterway and in compliance with current or proposed land use ordinances. Evaluation of this criterion includes the use of hydrographic and flood plain maps and soil survey information.

Potential for land degradation

Land degradation is a serious environmental problem and can be defined as the decline in condition or quality of the land as a consequence of human activities. When considering this criterion, it is necessary to assess the current status of the land and the extent of degradation of the site. It also assesses the sensitivity of the site to land degradation factors. The primary factor in evaluating the sites using this criterion is the amount of deforestation that would have to occur during construction.

Hazardous chemical risks

While a number of chemicals are used in the water treatment process, the chlorine used for disinfection of the water is the most significant in terms of potential hazards outside the WTP boundaries. Chlorine is therefore the focus of the assessment of hazardous chemical risks. The risk assessment process involves identifying different scenarios under which chlorine could be released, modeling the resulting concentration of chlorine at various distances from the release, and assessing the acceptability with injury limits. At this time, all sites would be considered equally susceptible to hazardous chemicals.

Community amenity

Community amenity is a term often used to describe the potential impacts of a development on the lifestyle of the local community. In the case of the proposed WTP, the issues considered under community amenity include: visual amenity, or what the WTP looks like and what impacts it might have on the view from residents' properties; impacts from plant lighting and noise generated by plant operations trucks entering and leaving the WTP site; traffic congestion; and road safety. Since the plant has not yet been designed, the community amenity has not been established in terms of visual impact. Road safety and access will be the primary criterion used to evaluate community amenity. It is assumed that plant lighting and noise would be similar for all sites.

Recreational and tourism values

This criterion relates to the potential impacts of the WTP on the users and managers of recreational and tourism facilities in the area in terms of convenience and enjoyment. Some of these impacts may be direct; for example, some walking trails pass through proposed WTP sites or their buffer zones, and would have to be rerouted. Other impacts are less tangible; for example, the WTP may impact the visual amenity of people using facilities such as picnic or scenic areas.

North Carolina heritage

Consideration of potential impacts of the WTP on North Carolina heritage has many dimensions. The construction of the WTP on some sites could disrupt historical artifacts or areas where it is expected that artifacts could be found based upon knowledge of the site's history. Construction could require that old buildings be moved from their original locations, which is undesirable. Conversely, the WTP could have a positive contribution to heritage values, representing the latest chapter in the story of the City of Raleigh's water supply. Both potential negative aspects and positive enhancement opportunities will be considered in assessing the overall North Carolina heritage impacts of each site. The National Register of Historic Places for Wake County, North Carolina will be used to identify places of historic significance.

Indigenous heritage

The assessment of the indigenous heritage value of each site is based on the significance of the site to the indigenous groups in the area, and the presence of archeological sites containing indigenous artifacts. The North Carolina Office of State Archaeology will be consulted when evaluating this criterion.

Site flexibility and operability

These criteria relate to the planning, design and operational phases of the project from an engineering perspective. Site flexibility is a reflection of the range of options available to planners and designers in configuring the WTP on the site, as well as the site's potential to accommodate changing circumstances and new technologies. Two of the largest determining factors in site flexibility are the amount of land and the topography of the site. The larger the land area available, the more flexibility the site provides.

Operability relates to the ease with which a plant located on the site could be operated and maintained on a daily basis, which is related to its layout and design. In assessing the flexibility and operability of each site, the following factors will be considered: expandability, topography, plant size, accessibility and security, ease of fire management, proximity to raw water and ease of backwash water disposal.

Lost opportunity

Local Town planning offices are familiar with current or long-term development considerations on large parcels within their jurisdictions. An important aspect of site evaluation is the potential for lost opportunity associated with construction of a water treatment plant on an otherwise large developable parcel. The local planning jurisdictions will be consulted to help identify such parcels so

that the evaluation and selection team can begin to quantify the lost opportunity associated with each site.

Evaluation:

The following is offered as an example of how evaluations may be conducted. In this example, using the simple comparison technique, each site would be rated against each other site using a chart similar to the following:

	1	2	3	4	5	6	7	8
1								
2	1 v 2							
3	1 v 3	2 v 3						
4	1 v 4	2 v 4	3 v 4					
5	1 v 5	2 v 5	3 v 5	4 v 5				
6	1 v 6	2 v 6	3 v 6	4 v 6	5 v 6			
7	1 v 7	2 v 7	3 v 7	4 v 7	5 v 7	6 v 7		
8	1 v 8	2 v 8	3 v 8	4 v 8	5 v 8	6 v 8	7 v 8	

Each time a site is selected, it is awarded a point, allowing each site to be ranked for each criterion. For each criterion, then, the preferred site is given eight points, the next preferred site seven, and so on. These points are then multiplied by a weighting factor. Once all criteria have been evaluated, the total points are summed, with the site receiving the most points being the overall preferred site.

Weighting

Weighting is the process by which the relative significance of each criterion is evaluated compared to the other criteria. This process of deriving weights is fundamental to the effectiveness of a multi-criteria analysis process as it involves individual perspectives and values that vary from criterion to criterion.

Weightings for this evaluation and selection process have been established based on Stearns & Wheler GHD projects, and other similar site selection projects employing multi-criteria analysis. Table 4 below summarizes the draft criterion weights to be applied to the various sites.

Table 4 – Criterion Weights

Main Criterion	Sub Criterion	Criterion Weighting
Technical and Economic Criteria		
Sufficient Area	Useable area	5
	Opportunity for buffer zone	
	Area for potential upgrades	
	Site shape	
Potential for Land Degradation	Slope and terrain	3
	Geo-hazards	
	Soils	
	Proximity to groundwater	
	Existing structures	
Waterways	Storm drainage	2
	100-year flood plain	
Proximity to Raw Water Pumping and Finished Water Interconnects		5
Site Operability	Electric power	1
	Gas	
	Sewer	
Site Flexibility	Construction access	2
	Availability of staging area	
Land Costs		3
Environmental Criteria		
Biodiversity		5
Impact on Wetlands		3
Impact on Surface Waters		3
Impacts on Groundwater		5
Indigenous Heritage		4
Community Criteria		
Community Amenity	Minimal displacement of housing and businesses	5
	Visual resources	
	Adequate vehicle access	
	Traffic disruption	
Recreational and Tourism Value	Opportunities for co-development	2
North Carolina Heritage		4

These weights will be applied to the site rankings for each criterion to develop an overall ordering of sites by preference. As noted, the MCA is used as a decision-aiding tool.